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Swiss Nitrous Oxide and Methane Emissions Estimated by Inverse Modelling

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Globally, long-lived non-CO_2 greenhouse gases (GHG; methane, nitrous oxide and synthetic gases) account for approximately 30 % of the radiative forcing of all anthropogenic GHG emitted until today. Estimates of their emissions are often associated with relatively large uncertainties when compared with those of CO_2. To support national inventory reporting, it is therefore essential to focus 'top-down' methods on non-CO_2 greenhouse gases, in order to reduce uncertainties and relate emission amounts and trends to realised or envisaged reduction measures.

Previously, we successfully estimated CH4 emissions on the Swiss scale using atmospheric observations and spatially resolved inverse modelling techniques [1]. We briefly update these previous estimates, extending the analysis to the period 2013 to 2017. The main part of the contribution will focus on novel analyses of nitrous oxide (N2O) emissions in Switzerland, which are an important contributor to the GHG budget from agriculture. In contrast to CH4, N2O poses several additional challenges for inverse modelling due to the required higher precision of atmospheric observations (small variability on large background mole fraction) and the expectation of temporally and spatially more variable N2O emissions (hot moments and hot spots). We use continuous, high-precision, atmospheric observations (laser spectroscopy) on the Swiss Plateau as well as from the neighbouring mountain-top sites Jungfraujoch and Schauinsland combined with high-resolution Lagrangian particle dispersion modelling (FLEXPART-COSMO) in connection with two different Bayesian inversion systems (grid inversion and sector inversion) to estimate monthly resolved emissions for the Swiss domain and for the period March 2017 to September 2018. Despite the more challenging nature of N2O emissions, we obtain excellent agreement between observed and simulated N2O atmospheric mole fractions, highlighting the benefits of high-precision measurements. In general, we find good agreement of the total Swiss N2O emissions between our 'top-down' estimate and the national inventory reporting (NIR) 'bottom-up' reporting. However, uncertainties in the transport model's boundary conditions can induce considerable differences in national total emission estimates. In addition, robust seasonality, with reduced emissions in winter time, was estimated. The majority of Swiss N2O emissions originate from agricultural and natural soils. The observed emission seasonality was mostly driven by these emissions and its monthly variability could largely be related to average soil properties on the Swiss Plateau (i.e. soil temperature and water filled pore space). Special attention will be given to the exceptionally dry summer 2018 and its impact on N2O emissions.

References

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